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GEOCHEMICAL INVESTIGATION OF FLUID INVOLVEMENT IN EXHUMED FAULTS OF THE SAN ANDREAS SYSTEM: COLLABORATIVE RESEARCH WITH TEXAS A&M UNIVERSITY, AND SAINT LOUIS UNIVERSITY.

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TECHNICAL ABSTRACT

Characterizing the structural, physical, and chemical properties of rock in fault zones is necessary to understand the mechanical, fluid flow and geophysical properties of the lithosphere. This paper provides a detailed characterization of the structure of two large-displacement, strike-slip fault zones of the San Andreas system in southern California, the Punchbowl and North Branch San Gabriel faults. Each fault consists of a broad zone of fractured and faulted rock (the damage-zone) containing one, or more, narrow, tabular zones of highly deformed rock (the fault-core). The subsidiary faults and fractures of the damage-zone form throughout the faulting history during episodes of locally high deviatoric stress. The fault-core is composed of extremely fine-grained and altered fault-rocks that reflect stress concentration, fluid-rock reactions, and extremely high shear strain. The characteristic and relatively ordered structure of large-displacement faults is the direct result of stress cycling and attrition wear as fault slip is accommodated within the fault core. Particle size distribution, layers of ultracataclasite, and mesoscopic-scale slip surfaces in the core of each fault zone record extreme localization of slip at the macroscopic and mesoscopic scale. Ultracataclasite is largely the product of abrasive wear and progressive accumulation from sliding on a single, long-lived slip surface in each fault-core. The relative stability of the slip surface is evidenced by the accumulation of progressively younger ultracataclasite towards the slip surface. Although not a common feature, the slivers of wall-rock contained within the ultracataclasite layer document occasional branching of the slip surface within the core of both fault zones. The damage-zone fault-core structure has significant implications to models of physical, mechanical and fluid-flow properties of fault zones in the brittle crust. Studies of fault zones in different tectonic settings, depth ranges, and host-rock

lithology are needed to document the universality of this structure, particularly the extreme localization of slip as is, observed in the Punchbowl and North Branch San Gabriel fault zones.

NON-TECHNICAL ABSTRACT

Knowledge of how and why earthquakes occur is critical in our effort to reduce the loss of life and property as a result of natural hazards. The physical processes operating in fault zones leading to earthquake slip nucleation, propagation and arrest occur deep within the earth's crust and can not be studied directly. One of the primary means of investigating earthquake faulting processes is through careful study of ancient faults that are presently exposed on the earth's surface due to erosion of overlying material. We are using a variety of analytic techniques to study the earthquake process, with special attention being given to the mechanical and chemical interaction of pore fluid and rock during faulting. This field study provides information to guide future experimental and theoretical modeling efforts and to test current hypotheses of the faulting process. This and related work will ultimately provide a sound mechanistic understanding of the earthquake faulting process that will help us understand how and why earthquakes occur.